

**INDIANA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS MANAGEMENT**

**SPECIFIC GRAVITY FACTOR AND ABSORPTION
OF
LIGHTWEIGHT FINE AGGREGATE
ITM 222-15T**

1.0 SCOPE.

- 1.1** This test method covers the procedures for determining the absorption of lightweight fine aggregate in the laboratory and the field and the specific gravity factor.
- 1.2** This ITM may involve hazardous materials, operations, and equipment and may not address all of the safety problems associated with the use of the test method. The user of the ITM is responsible for establishing appropriate safety and health practices and determining the applicability of regulatory limitations prior to use.

2.0 REFERENCES.

2.1 AASHTO Standards.

- M 231 Balances Used in the Testing of Materials
- T 84 Specific Gravity and Absorption of Fine Aggregate
- T 164 Quantitative Extraction of Asphalt Binder from Hot Mix Asphalt (HMA)
- T 248 Reducing Samples of Aggregate to Testing Size
- T 255 Total Evaporable Moisture Content of Aggregate by Drying

2.2 ASTM Standards.

- C 1761 Lightweight Aggregate for Internal Curing of Concrete

2.3 ITM Standards.

- 207 Sampling Stockpiled Aggregates

3.0 TERMINOLOGY. Definitions for terms and abbreviations shall be in accordance with the Department's Standard Specifications, Section 101 and as follows for this test method for lightweight fine aggregate:

- 3.1** Absorption. The increase in the weight of aggregate due to water penetrating into the permeable pores of the particles, expressed as a percentage of the oven-dry weight of the sample. In the laboratory, water penetration is achieved by submerging the aggregate for a period of $24\text{h} \pm 1$ hour. For field conditions, the

water penetration is achieved by pre-wetting the aggregate by soaking and draining the stockpile for the periods specified.

- 3.2** Autogenous Shrinkage. Reduction in volume due to chemical shrinkage of a sealed cementitious mixture, not subjected to external forces and under constant temperature, measured from the time of final setting.

The chemical shrinkage leads to emptying of the internal pores (see self-desiccation) resulting in the formation of menisci in the partially water-filled pores. The menisci in turn result in internal tensile stresses that cause bulk shrinkage. While autogenous shrinkage is due to chemical shrinkage, the magnitude of autogenous shrinkage is less than the chemical shrinkage after setting occurs because the aggregate particles and the hydrated cementitious paste network restrain the shrinkage. The restraint may in turn result in cracking.

- 3.3** Internal Curing. Supplying water within a cementitious mixture using pre-wetted aggregate, or other materials that readily release water from within the particles, thereby mitigating self - desiccation and sustaining hydration

- 3.4** Pre-Wetted Aggregate. For laboratory applications, pre-wetted aggregate is material that has been completely submerged in water for 24 ± 1 h and the excess water decanted. For field applications, pre-wetted aggregate is aggregate that has been stockpiled and has had the specified soaking and drainage periods.

- 3.5** Pre-Wetted Surface-Dry Aggregate. The condition in which the permeable pores of aggregate particles are filled with water, to the extent achieved by pre-wetting in the laboratory or field, and the surfaces of the particles are dry

- 3.6** Specific Gravity Factor. The condition in which the permeable pores of lightweight aggregate particles are partially filled with water, to the extent achieved by submerging an oven-dry specimen for a 24h period in the laboratory or soaking and draining a stockpile as required by the specifications, and the surfaces of the particles are dry

- 3.7** Self-Desiccation. Reduction in the internal relative humidity of a sealed cementitious mixture, due to chemical shrinkage, that may reduce the rate of hydration or stop hydration

- 4.0** **SIGNIFICANCE AND USE.** This test method is used to determine the specific gravity factor and absorption of lightweight fine aggregates used for the mix design and quality control of internally cured concrete. Internal curing provides an additional source of water to sustain hydration and substantially reduce the early-age autogenous shrinkage and self-desiccation that may be significant contributors to early-age cracking.

Specific gravity factor and absorption generally vary as the level of absorbed water into the fine aggregate particles increases. Complete saturation of the permeable voids in some lightweight fine aggregate particles is difficult to obtain. The specific gravity factor and absorption, as measured in the laboratory, are intended to be used in proportioning the concrete mix design for the purpose of internal curing and to monitor material uniformity during production. The specific gravity factor and absorption as measured in the field are intended to be used in establishing the batch weights for the concrete at the time of production.

5.0 APPARATUS.

- 5.1** Balance, Class G2, in accordance with AASHTO M 231
- 5.2** Containers as needed
- 5.3** Drying apparatus, gas burner or ventilated oven, capable of heating to $230 \pm 9^{\circ}\text{F}$
- 5.4** Extraction apparatus, centrifuge, in accordance with AASHTO T 164 Method A, with controls for the time of operation and maximum speed
- 5.5** Filter ring, felt or paper, to fit the rim of the bowl
- 5.6** Fire shovel
- 5.7** Measuring cup, 1/2 cup capacity
- 5.8** Pycnometer, 2 qt.
- 5.9** Sampling tube, 3 in. minimum in diameter and 3 ft minimum in length
- 5.10** Spatula, metal, with a straight edge
- 5.11** Spoons and brushes as needed

6.0 PROCEDURE – LABORATORY ABSORPTION

- 6.1** Obtain a 25 lb sample of lightweight fine aggregate in accordance with ITM 207
- 6.2** Reduce the sample in accordance with AASHTO T 248, Method C using the measuring cup. Six measuring cups of material shall be obtained. Each measuring cup of material shall be struck off with the spatula and placed in a container (Note 1).

Note 1 - The reduced sample may be placed into the dry and weighed centrifuge bowl in accordance with 6.4 prior to drying by 6.3.

- 6.3** Dry the sample to a constant weight at a temperature of $230 \pm 9^{\circ}\text{F}$ (Note 2). After constant weight is obtained, allow the sample to cool to ambient temperature.

Note 2 - Constant weight is defined as the weight at which further drying for 15 minutes at the required temperature does not alter the weight by more than 0.1 percent of the original weight.

- 6.4** Weigh a dry centrifuge bowl to the nearest 0.1 g (W_1). Place the sample into the centrifuge bowl and distribute the sample evenly inside the bowl to assure a proper balance of the material. Record the weight of the sample and centrifuge bowl to the nearest 0.1g (W_2). Cover the sample with water and permit to stand for 24 ± 1 h.
- 6.5** Decant the excess water from the submerged sample with care to avoid any loss of fines.
- 6.6** Place the filter ring around the edge of the centrifuge bowl, clamp the cover on tightly, and place an appropriate container under the drain to collect the extract.
- 6.7** Start the centrifuge revolving slowly and gradually increase the speed to 2000 ± 20 rpm. Once the centrifuge has obtained 2000 ± 20 rpm, the test shall begin and continue at that speed for 3 minutes after which the centrifuge is turned off.
- 6.8** Weigh the centrifuge bowl and pre-wetted surface-dry sample to the nearest 0.1g (W_3)
- 6.9** Calculate the laboratory absorption as follows:

$$\text{Laboratory Absorption, \%} = \frac{S_{24} - A}{A} \times 100$$

where:

S_{24} = weight of pre-wetted surface-dry sample, g, ($W_3 - W_1$)

A = weight of dry sample, g, ($W_2 - W_1$)

W_1 = weight of dry centrifuge bowl, g

W_2 = weight of centrifuge bowl and dry sample, g

W_3 = weight of centrifuge bowl and pre-wetted surface-dry sample, g

7.0 PROCEDURE – FIELD ABSORPTION

- 7.1** Weigh a dry centrifuge bowl to the nearest 0.1 g (W_1).
- 7.2** Weigh a dry container to the nearest 0.1g (W_2)

- 7.3** After the stockpile has been soaked and drained as required by the specification, obtain a 25 lb sample of lightweight fine aggregate in accordance with ITM 207.
- 7.4** Reduce the sample in accordance with AASHTO T 248, Method C using the measuring cup. Six measuring cups of material shall be obtained. Each measuring cup of material shall be struck off with the spatula and placed in the dry centrifuge bowl. The sample shall be distributed evenly inside the centrifuge bowl to assure a proper balance of the material (Note 3).
- Note 3 – If the total moisture content of the sample is to be determined in accordance with AASHTO T 255, the weight of the pre-wetted sample and centrifuge bowl shall be obtained.
- 7.5** Place the filter ring around the edge of the centrifuge bowl, clamp the cover on tightly, and place an appropriate container under the drain to collect the extract.
- 7.6** Start the centrifuge revolving slowly and gradually increase the speed to 2000 ± 20 rpm. Once the centrifuge has obtained 2000 ± 20 rpm, the test shall begin and continue at that speed for 3 minutes after which the centrifuge is turned off.
- 7.7** Weigh the centrifuge bowl and pre-wetted surface-dry sample to the nearest 0.1g (W_3)
- 7.8** Transfer the sample from the centrifuge bowl to the dry weighed container. Place the sample and container on the drying apparatus and dry to a constant weight (Note 1) at approximately 230 °F (Note 4). Cool the sample to ambient temperature and weigh the sample and container to the nearest 0.1g (W_4).

Note 4: -- If a gas burner is used, care shall be taken in heating and containing the sample. Very rapid heating may cause some particles to explode, resulting in loss of particles.

- 7.9** Calculate the field absorption as follows:

$$\text{Field Absorption, \%} = \frac{S_{\text{PSD}} - A}{A} \times 100$$

where:

S_{PSD} = weight of pre-wetted surface-dry sample, g, ($W_3 - W_1$)

A = weight of dry sample, g, ($W_4 - W_2$)

W_1 = weight of dry centrifuge bowl, g

W_2 = weight of dry container, g

W_3 = weight of centrifuge and pre-wetted surface-day sample, g

W_4 = weight of container and dry sample, g

8.0 PROCEDURE - SPECIFIC GRAVITY FACTOR

- 8.1** Repeat steps in 6.0 or 7.0 to obtain an aggregate in a pre-wetted surface-dry condition. Record the weight to the nearest 0.1 g (W_5), which is equal to S_{24} or S_{PSD} that represents the laboratory or field condition, as appropriate.
- 8.2** Determine the weight of the pycnometer filled to the calibration mark with water at $73.4 \pm 3.5^\circ\text{F}$ to the nearest 0.1g (B).
- 8.3** Partially fill the pycnometer with water. Immediately introduce the pre-wetted surface-dry sample into the pycnometer and fill with additional water to approximately 90 percent of the capacity of the pycnometer.
- 8.4** Manually roll, invert or agitate the pycnometer to remove all air bubbles in the pycnometer in accordance with Section 8.2 of AASHTO T 84. Adjust the water temperature to $73.4 \pm 3.5^\circ\text{F}$, if necessary, and bring the water level to the calibration mark. Record the weight of the pycnometer, sample, and water to the nearest 0.1g (C).
- 8.5** Calculate the specific gravity factor as follows:

$$\text{Specific Gravity Factor} = \frac{W_5}{(B + W_5 - C)}$$

where:

W_5 = weight of pre-wetted surface-dry sample, g, which is equal to S_{24} or S_{PSD} representing the laboratory or field condition, as appropriate
B = weight of pycnometer filled with water to calibration mark, g
C = weight of pycnometer with sample and water filled to calibration mark, g

9.0 REPORT.

- 9.1** Record the absorption to the nearest 0.01%.
- 9.2** Record the specific gravity factor to the nearest 0.001.

LABORATORY ABSORPTION WORK SHEET

LABORATORY ABSORPTION		
Procedure	Method	Test Value
Weight of dry centrifuge bowl, 0.1 g (W_1)	Weigh	
Weight of dry centrifuge bowl and dry sample, 0.1g (W_2)	Weigh	
Weight of dry sample, 0.1g, (A)	$W_2 - W_1$	
Weight of centrifuge bowl and pre-wetted surface-dry sample, 0.1g (W_3)	Weigh	
Weight of pre-wetted surface-dry sample, 0.1g, (S_{24})	$W_3 - W_1$	
Laboratory Absorption, 0.01%	$\frac{S_{24} - A}{A} \times 100$	

Remarks: _____

Signature: _____ Title: _____ Date: _____

FIELD ABSORPTION WORK SHEET

FIELD ABSORPTION		
Procedure	Method	Test Value
Weight of dry centrifuge bowl, 0.1 g (W_1)	Weigh	
Weight of centrifuge bowl and pre-wetted surface-dry sample, 0.1g (W_3) [Note 1]	Weigh	
Weight of pre-wetted surface-dry sample, 0.1g, (S_{PSD})	$W_3 - W_1$	
Weight of dry container, 0.1g (W_2)	Weigh	
Weight of dry container and dry sample, 0.1g (W_4)	Weigh	
Weight of dry sample, 0.1g, (A)	$W_4 - W_2$	
Field Absorption, 0.01%	$\frac{S_{PSD} - A}{A} \times 100$	

Remarks: _____

Signature: _____ Title: _____ Date _____

Note 1: To determine Total Moisture Content per Note 3 in article 7.4 of this ITM, the weight of centrifuge bowl and pre-wetted sample can be recorded here, to the nearest 0.1 g _____. This is done prior to determining W_3 for the sample in the pre-wetted surface-dry condition. The weight of the dry centrifuge bowl (W_1) must be subtracted in order to obtain the weight of the stockpile sample in the pre-wetted condition prior to drying for Total Moisture Content determination.

SPECIFIC GRAVITY FACTOR WORK SHEET

SPECIFIC GRAVITY FACTOR		
Procedure	Method	Test Value
Weight of pre-wetted sample, 0.1g (W_5) S_{24} or S_{PSD} as appropriate to testing lab or field conditioning	Weigh	
Weight of pycnometer filled with water to calibration mark, 0.1g (B)	Weigh	
Weight of pycnometer with sample and water to calibration mark, 0.1g (C)	Weigh	
Specific Gravity Factor (.001)	$\frac{W_5}{(B + W_5 - C)}$	

Remarks: _____

Signature: _____ Title: _____ Date: _____